

REMARKS

Reconsideration and allowance of this application, as amended, is respectfully requested.

This Amendment is in response to the Office Action dated August 19, 2004.

By the present Amendment, independent claims 1 and 7 have been amended to clarify the invention. Also, new dependent claims 8 to 10 have been added to define further features of the present invention.

Briefly, the present invention is directed to a fuel injection valve arrangement which can increase the velocity of the injection flow to improve atomization. Figs. 2 and 3 show a first embodiment of the invention, while Fig. 4 shows a second embodiment. Figs. 5, 6 and 7 provide illustrations of how the present invention operates to modify the velocity distribution to improve atomization.

Referring to Fig. 1, solely for purposes of example, a detailed view of a fuel injection nozzle according to the first embodiment of the invention is shown. As illustrated there, fuel passes through injection holes 107 formed in a plate member 111 to generate fuel sprays 202. In accordance with the present invention, grooves 201 are provided in the flat portion plate 111 facing toward the upstream side of the fuel passage. Fig. 3 shows the embodiment of the invention in which these grooves 201 are annular grooves which substantially completely surround the injection holes 107. Fig. 4 shows an alternative embodiment of the invention in which each groove is actually a plurality of groove portions arranged discontinuously in the circumferential direction around each of the injection holes 107.

Referring to Fig. 5, the groove 201 in the flat portion of the plate 111 is shown to cause an overflow 502. Referring to Figs. 6 and 7, the advantage of this overflow

502 can be seen in terms of the velocity distribution. For example, as noted on page 7, lines 7 et seq. of the Substitute Specification:

"As will be seen from Fig. 7, with the provisions of the grooves 201, since the overflow 502 and the contracted flow portion 602 are formed, the maximum flow velocity in the flow velocity distribution 702 at the injection hole portion is increased in comparison with that in a flow velocity distribution 701 in the case of no provision of the grooves 201. Because of this acceleration effect, the turbulence of the gas and the liquid interface between the fuel and the areas enhanced, and a large number of vortexes 603 are formed, which reduces the diameter of the spray particle 605."

In other words, the atomization is improved because of the reduction of the diameter of the spray particle 605.

Reconsideration and removal of the rejection of claims 2-7 is respectfully requested (noting that claim 1 has been deleted, without prejudice, to concentrate on the features shown in claims 2-7). By the present Amendment, independent claims 2 and 7 have both been amended to emphasize the distinctions of the structure of the present invention over the cited reference to Haltiner (USP 6766969) relied on in rejecting the claims in the Office Action. Specifically, each of these claims now defines that the flat portion is provided between injection holes on a first face of the plate member which faces toward the upstream side of the plate member (in other words, toward the valve seat). In addition, each of the claims has been amended to specifically define that the groove is formed in the flat portion such that the groove is recessed in the flat portion relative to the openings of the injection holes in the flat portion. This feature can be appreciated from Figs. 2, 6 and 7, for example. As shown in these figures, the grooves 201 are recessed in the flat portion relative to the higher position of the openings of the injection holes in the same flat portion. For

the Examiner's convenience, a marked copy of Fig. 7 is provided in the Appendix herewith to illustrate this feature.

Turning to the Haltiner reference, on the other hand, it is clear that the flat portion 60 in which the injection holes 56 are formed do not have any grooves corresponding to the claimed grooves of the independent claims 1 and 7 (or shown as the grooves 201 in the drawings of the present application.) This is shown in Appendix B, for example. On the contrary, the structure of Haltiner uses projections 54, rather than grooves, which will not provide the same beneficial results as the present claimed invention. In particular, the Haltiner reference will fail to obtain the overflow (such as shown by 502 in the figures of the present drawings) in the manner obtained by the grooves of the present claimed invention. Therefore, it is respectfully submitted that the present claimed invention structurally distinguishes over Haltiner, particularly in light of the amendments presented herein. It is also noted that Haltiner fails to obtain the benefits of the overflow, the improved velocity distribution and the improved atomization, shown, for example, in Figs. 6 and 7 of the present application. Therefore, reconsideration and allowance of claims 2-7 over Haltiner is respectfully requested.

Reconsideration and allowance of newly presented dependent claim 8 is also respectfully requested. As noted above, this claim defines features shown, for example, in Fig. 4 (noting that reference to Fig. 4 is solely for purposes of example). It is respectfully submitted that this claim even further defines over the Haltiner reference. Therefore, reconsideration and allowance of dependent claim 8 is also respectfully requested.

If the Examiner believes that there are any other points which may be clarified or otherwise disposed of either by telephone discussion or by personal interview, the Examiner is invited to contact Applicants' undersigned attorney at the number indicated below.

To the extent necessary, Applicants petition for an extension of time under 37 CFR 1.136. Please charge any shortage in fees due in connection with the filing of this paper, including extension of time fees, to the Antonelli, Terry, Stout & Kraus, LLP Deposit Account No. 01-2135 (Docket No. 503.42954X00), and please credit any excess fees to such Deposit Account.

Respectfully submitted,

ANTONELLI, TERRY, STOUT & KRAUS, LLP

By



Gregory E. Montone
Reg. No. 28,141

GEM/dlt

1300 North Seventeenth Street, Suite 1800
Arlington, Virginia 22209
Telephone: (703) 312-6600
Facsimile: (703) 312-6666

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APPENDIX A



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FIG. 6

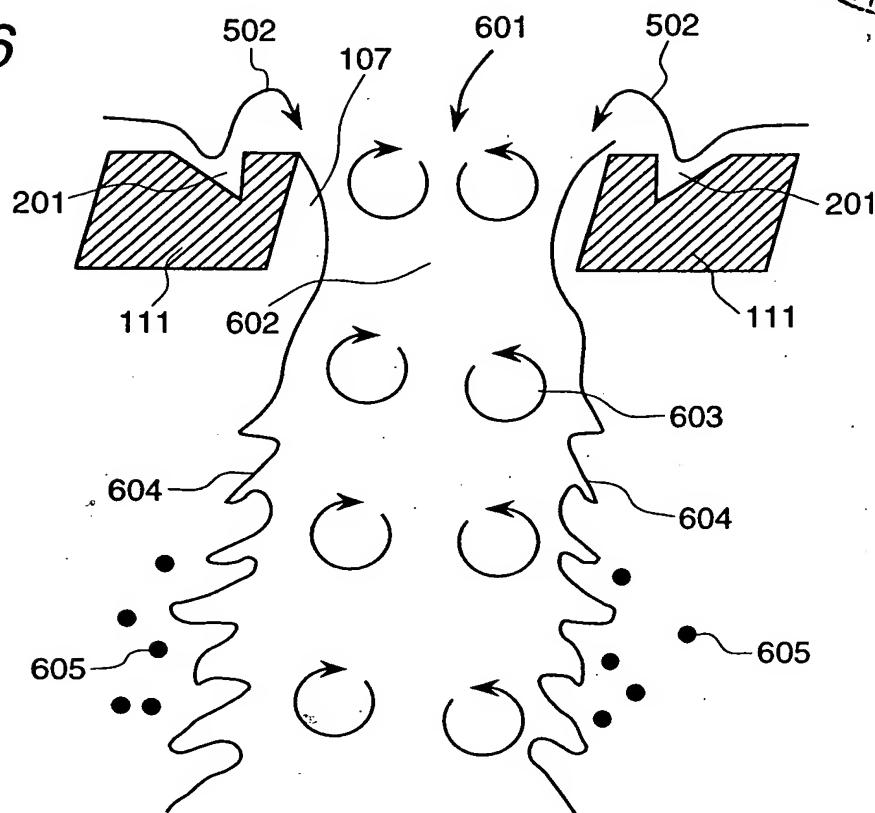
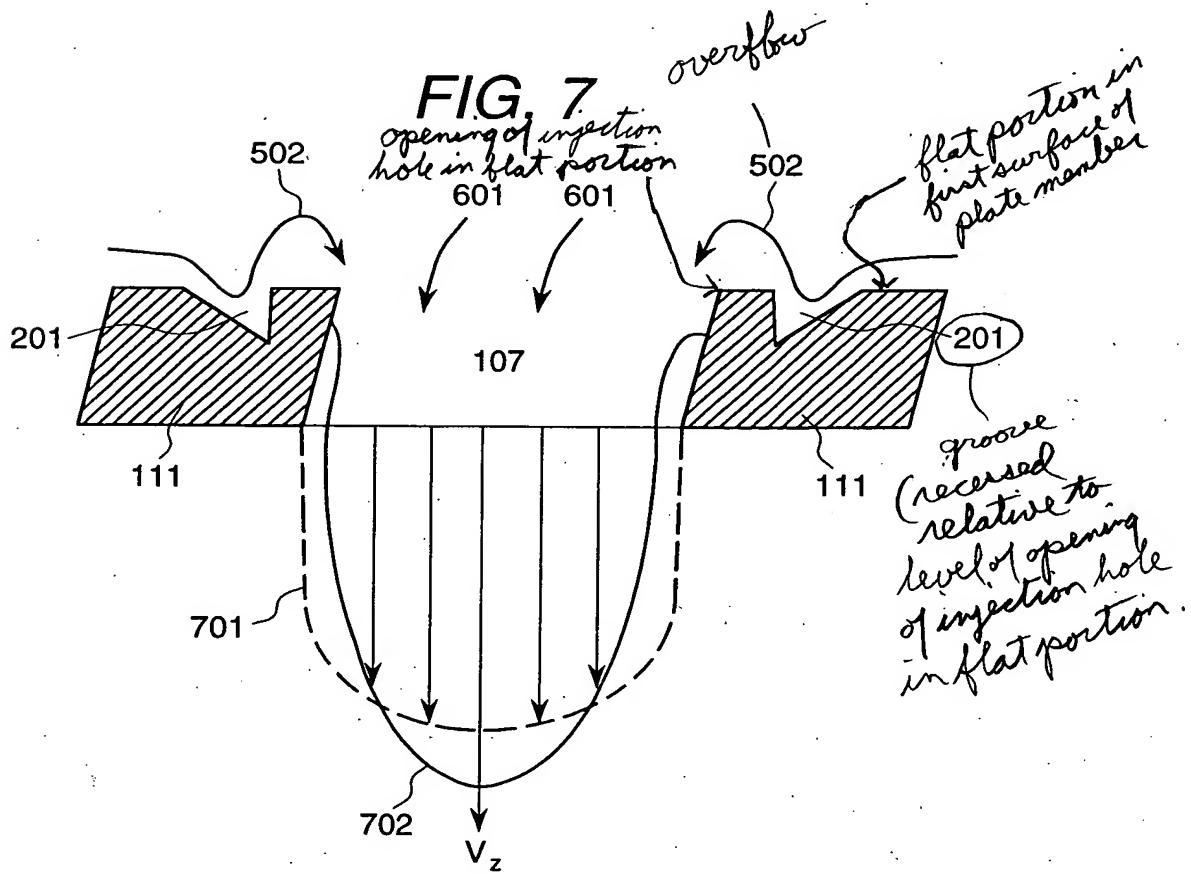


FIG. 7



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APPENDIX B

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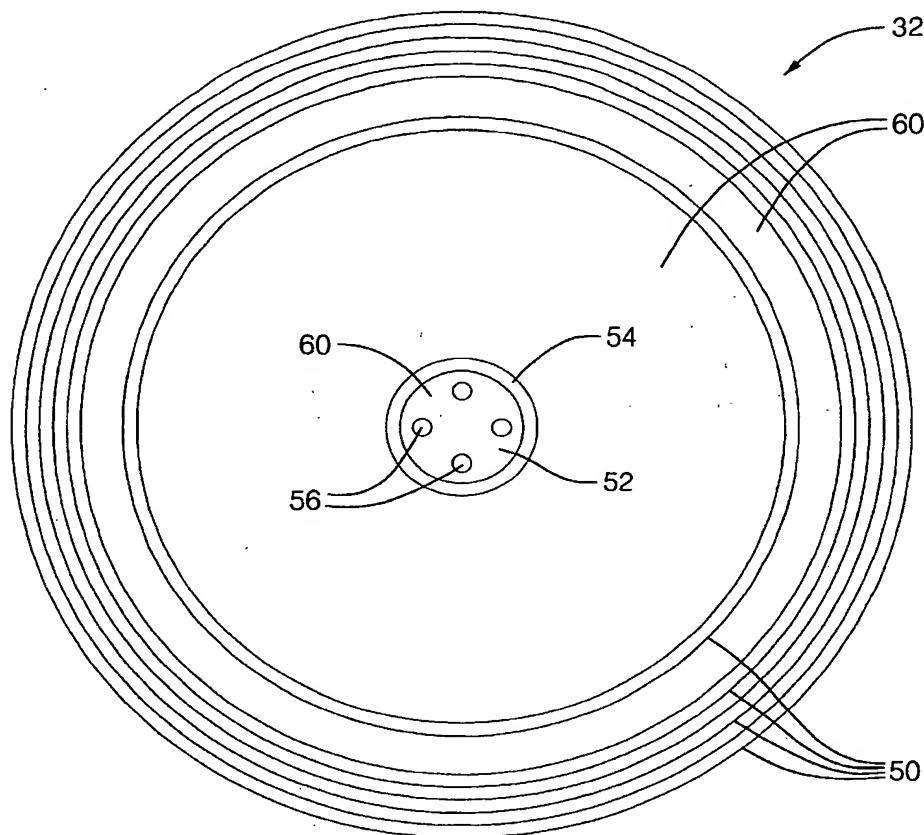


FIG. 2

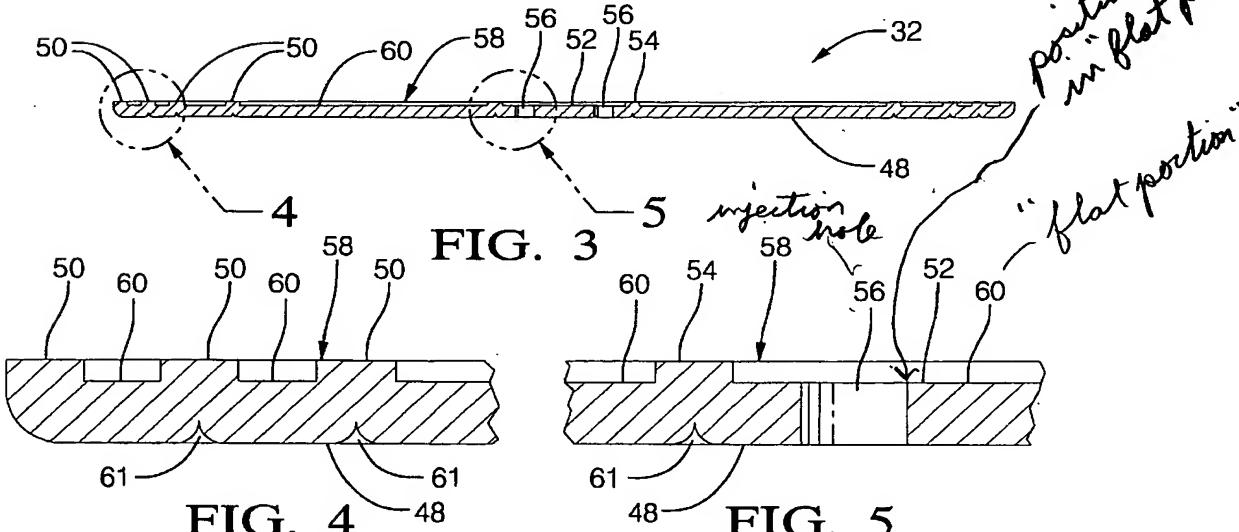


FIG. 4

FIG. 5

(no structure corresponding to groove in flat portion which is recessed relative to the position of the opening of the injection hole in the flat portion).